Seton River Corridor Habitat Restoration Assessment

Photo Courtesy of Kim North

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1.0 Introduction

1.1 Background

The Seton River flows east out of Seton Lake and joins the Fraser River at Lillooet, BC. The river and its corridor have historically provided important habitats for a remarkable abundance of fish and wildlife species, and have been a part of the traditional territory of the St'at'imc Nation (Cayoose Band) for thousands of years. Since the early 1900s, the corridor has been subject to a wide range of development, including: roadways; residential, commercial, and industrial development; day-use and overnight camping areas; railways; and hydroelectric development (dam, power canal, aqueduct, transmission line rights-of-way, etc.). Over time, the cumulative effects of these developments have significantly altered the river channel and adjacent riparian habitats.

The Seton River corridor continues to have high fisheries and wildlife values; however the impacts of development on the availability and suitability of habitats has been significant. With the intention of assessing the existing habitat conditions in the corridor, and the potential for restoration opportunities, a set of baseline information to document the existing conditions is required.

1.2 Study Area

Seton Dam, a BC Hydro facility that is managed as a part of the Bridge River Generation area, regulates flow in the Seton River. Water releases from the dam are managed between a minimum of 5 m^3/s and a maximum of over 100 m^3/s.

Cayoosh Creek joins the Seton River ca. 4 km upstream of its confluence with the Fraser River. A small power generating station on the creek is operated as a run-of-the-river facility. As such, flow volumes in Cayoosh Creek are largely unregulated and can vary greatly on a seasonal basis.

Two spawning channels (upper and lower) were developed adjacent to the Seton River as compensation for the impacts of development on fish and wildlife habitats within the corridor. The Upper Spawning Channel is located near the tailrace of Seton Dam; The Lower Spawning Channel is located below the confluence with Cayoosh Creek. Both channels receive a constant and continuous flow via siphons from the BC Hydro Power Canal. Habitats within the channels have been complexed to support spawning and rearing by both resident and anadromous fish species.

Sampling in 2010 and 2011 was focussed on the Lower Spawning Channel. For the purposes of the monitoring assessments, the channel was divided into 26 sections (Figure 1). Data collected for the salmon spawner surveys conformed to these section designations to document spawner distribution and relative use of different regions of the spawning channel.

1.3 Objectives

Given the high fish and wildlife values, and the existing impacts of development in the Seton River corridor, it is very important to document habitat conditions and use by resident and anadromous fish species, as well as assess the potential for future restoration opportunities. The goal of the work in 2010 was to conduct some sampling to collect data on use of the Lower Spawning Channel by juvenile and

Figure 1 Map of the Seton River Lower Spawning Channel showing the 26 sections used for the salmon spawner surveys.

resident fish and aquatic invertebrate species.

One of the goals of the work in 2011 was originally to conduct a quantitative electrofishing method (i.e., multi-pass, closed section, depletion-type sampling) to build on the dataset of juvenile and resident fish from 2010, and collect more rigorous information on the species assemblage, abundance, and distribution of these species and age classes in the channel. However, the earlier-than-anticipated arrival of sockeye spawners in the channel precluded this sampling objective in 2011 due to concern about potential impacts of electrofishing on the spawners and any deposited eggs. An additional objective in 2011 was to document salmon spawner abundance, timing, and distribution by conducting regular (ca. weekly) surveys of the Lower Spawning Channel. The focus of the surveys in 2011 was primarily for pink salmon; however, observations of other salmon species encountered were recorded as well. An additional objective in each year was to provide training opportunities for local technicians that are new to fisheries and aquatic studies.

1.4 Study Period

Sampling activities in 2010 were conducted during one mid-summer session between the end of July and the end of August. Water temperature loggers were deployed on 29 July and retrieved on 27 August, 2010. Aquatic invertebrate sampling baskets and periphyton accrual plates were deployed on 30 July. The baskets were retrieved on 25 August, and the plates were retrieved in mid September. Fish sampling was conducted between 17 and 25 August.

The salmon spawner surveys in 2011 were conducted between 8 August and 14 November on a ca. weekly basis. Water temperature loggers were deployed on 1 May 2011 and remain in the channel at this time.

2.0 Methods

The methods employed during sampling activities in 2010 and 2011 were intended for use by the Seton Corridor Restoration Program and its technicians for collecting some baseline information on aquatic invertebrate diversity, fish use, and spawner abundance in the Lower Spawning Channel. Previous sampling had not been conducted since the channels were continuously wetted (previously only operated every odd year for pink salmon spawning) and the habitat was complexed ca. 8 years ago. The goal of the sampling activities was to document current use of the channel by fish and invertebrate species. Information on species diversity, relative abundance, and distribution can be a key indication of water quality and existing habitat conditions in the channel. Such information is crucial for assessing the health of the channel ecosystem, determining the potential need for habitat improvements, and directing future restoration-type activities.

2.1 Air and Water Temperature Monitoring

Water temperatures were recorded hourly using data loggers (manufactured by Onset Computer Corporation) deployed at two locations within the Lower Spawning Channel; one was near the inlet siphon at the upstream end, the other was near the outlet of the channel at the downstream end. Air temperatures were recorded by a data logger mounted to the trunk of a large tree adjacent to the spawning channel. The loggers were deployed in 2010 (August only) and 2011 (1 May to the present).

2.2 Aquatic Invertebrate and Periphyton Accrual Sampling

Aquatic invertebrate and periphyton accrual sampling was completed in August 2010. Prior to the start of sampling, an overview survey of the Lower Spawning Channel was conducted to assess the available habitats and suitable sampling locations. The sampling locations were selected to incorporate the range of aquatic meso-habitat types available in the channel, which included: riffles, runs, and pools. A set of six samplers were deployed, two in each of the available habitat types.

Benthic macro-invertebrates were sampled using standardized metal baskets filled with small cobble substrate gathered from the stream bank. The baskets were closed together with zip ties and placed on the substrate, completely submerged below the water's surface. The samplers location was marked by attaching a piece of flagging tape labelled with the samplers number to the nearest piece of established vegetation (e.g., a bush or tree). The location, habitat type, time and date of deployment, and a depth and velocity measurement were recorded for each sampler in a field notebook. The baskets remained in place for 3 to 4 weeks to allow sufficient time for colonization by aquatic invertebrates. At the end of this colonization period, each basket was carefully removed from the streambed and immediately placed into a bucket with water. Each sampler was opened by clipping the zip ties to spill the entire contents into the buckets. Each of the small cobbles contained within the baskets was gently scrubbed by hand (or soft brush) to remove any attached material, including invertebrates. All of this material was then filtered through a fine mesh sieve and then picked and processed on site. The invertebrates picked from each sample were sorted, identified (to the lowest taxonomic level possible in the field), and enumerated.

Samplers to monitor periphyton algae accrual were also deployed at suitable depths and velocities near the locations of the invertebrate baskets. These samplers were used to make general observations about the growth of algae in the channel during a ca. 6-week summer sampling period; however, the intention was not to collect taxonomic or more rigorous accrual data from this sampling during 2010. The samplers (called plates) consisted of a 30 x 30 x 0.5 cm Styrofoam sheet, fixed to a same-sized plywood backing with rubber bands, which is bolted to a 30 x 30 x 10 cm concrete block. The plates were fully submerged and placed on the substrate in the spawning channel. The same information was recorded for the plates as for the invertebrate sampling baskets. At the end of the sampling period, each plate was photographed and general observations about the colour and volume of algae accrual were noted for each sampler.

The aquatic invertebrate and periphyton accrual sampling was conducted from 30 July to 25 August, and 30 July to ca. 15 September 2010, respectively.

2.3 Resident and Juvenile Fish Sampling

Sampling for resident and juvenile fish species was completed in August 2010. During the site survey conducted prior to the start of the aquatic invertebrate and periphyton sampling, suitable locations for fish sampling were also identified. Fish were sampled using Gee minnow traps, which can capture fish less than 200 mm long. The locations for fish sampling were selected to target the widest array of species possible within the sampling parameters of this method. Sampling with these traps selects for habitat preference, behaviour, and even species to some extent, so it does not provide a reliable indication of fish abundance in the channel. Instead, data from the fish sampling were used to document use of the channel by the fish species and age classes that were sampled.

The Gee minnow trap is a standardized piece of fish sampling equipment. The trap separates into two halves to enable the addition of bait and the removal of captured fish. Each trap was baited (i.e., using salmon roe or cat food) and fully submerged underwater. The traps were set in moderate to slow-moving flow near some form of instream cover (e.g., large woody debris, overhanging vegetation, instream boulder, etc.), where available, and oriented lengthwise in the current. As with the invertebrate samplers, the locations of each fish trap were marked by attaching a piece of flagging tape labelled with a unique number to the nearest piece of established vegetation. The location, habitat type, and time and date of deployment were recorded for each sampler in a field notebook. Each trap was deployed for ca. 24 hours for each set. At each check of the traps, captured fish were removed, anaesthetized, identified to species, and measured (to the nearest millimetre). Then, following a short recovery period, all fish were released back to the spawning channel. The traps were then moved to the next suitable site for subsequent deployment.

Initial deployment of the fish traps commenced on 17 August, 2010. Fish sampling continued until 25 August at which time all traps were removed from the channel.

2.4 Salmon Spawner Surveys

Salmon spawner surveys were conducted from 8 August to 14 November, 2011. The surveys were completed by a crew of typically two to four technicians, each wearing waders, a wading belt, polarized sunglasses, and a hat. Each crew member would walk alongside a separate section of the channel, in an upstream direction, and count each observed spawner according to species. Conditions for visual counts were ideal in the spawning channel due to the relatively narrow channel width and shallow depth of most of the survey sections, as well as good water clarity during the survey period. Counts were recorded in the field notes at the end of each section, and separate tallies were noted for live and dead spawners. Care was taken to avoid walking in the channel where possible, to minimize impacts to redds and avoid potential disruption of the count. Counts were completed for the entire length of the spawning channel during each survey.

Other parameters noted for each survey were: Date, time, air and water temperatures, weather, and crew initials. For sockeye salmon, a number of the carcasses were examined to determine sex, and whether or not the fish had spawned.

2.4 Data Compilation and Analysis

Following completion of the sampling, all collected data were entered into MS Excel spreadsheets. The aquatic invertebrate and juvenile and resident fish data were summarized to highlight the diversity of invertebrates and fish sampled.

Total escapement of pink salmon to the spawning channel was calculated using the area-under-the-curve method. Required for this method are: 1) systematic visual count data collected throughout the period the spawners are in the channel; 2) an estimate of observer efficiency; and 3) an estimate of the average amount of time a spawner spends in the channel before it dies, known as residence time (English, Bocking, and Irvine 1992).

3.0 Results and Discussion

3.1 Water Temperatures

Water temperatures from the two monitoring stations (upstream and downstream ends) within the Lower Spawning Channel during the 2011 sampling period are presented in Figure 2. Differences in the temperature profile between the two stations are illustrated in Figure 3. The same graphs for the temperature data recorded from 30 July to 27 August 2010 are provided in Appendix A, Figures A1 and A2. In general, the temperatures recorded in the spawning channel in August 2010 were very similar to temperatures recorded during that same period in 2011.

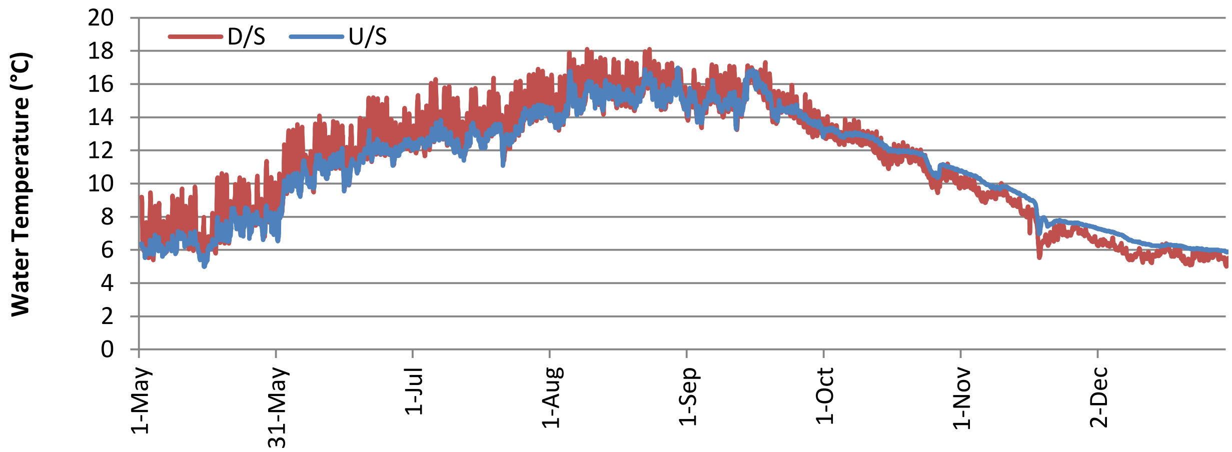

Figure 2 Hourly water temperatures recorded at two stations (upstream and downstream ends) within the Seton River Lower Spawning Channel, 1 May to 31 December 2011.

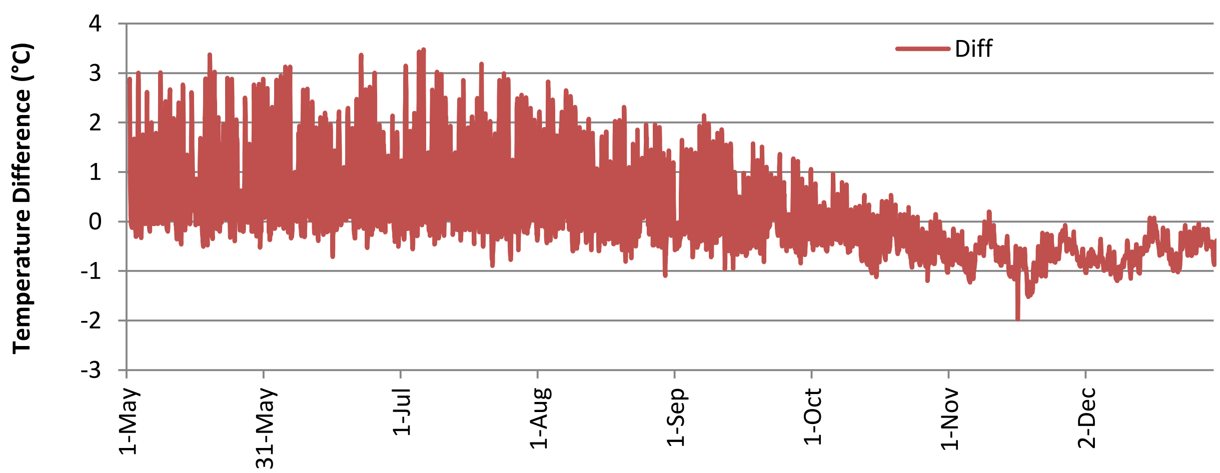

Figure 3 The differences in water temperatures between the upstream and downstream stations in the Lower Spawning Channel, 30 July to 27 August 2010.

Water temperatures ranged from a low of 5.0 degrees Celsius in both May and December, to a high of 18.1 degrees Celsius in August 2011. These temperatures are within the range of suitable temperatures for the maintenance of aquatic life. Not surprisingly, the temperatures at the upstream end of the spawning channel are quite similar to the temperatures in the Seton River above the Cayoosh Creek confluence (both are directly sourced from Seton Lake water). It seems likely that Seton River temperatures are cooler below the Cayoosh Creek confluence due to a mitigating influence of the Cayoosh Creek flows. Temperatures in the spawning channel are generally warmer at the downstream end during spring and summer, are fairly uniform along the entire channel length during early fall, and then become cooler at the downstream end by late fall and winter.

Interestingly, the temperature profile for the spawning channel was generally warmer (by several degrees on most dates) during summer, fall, and winter than temperatures recorded for those seasons in the Lower Bridge River below Terzaghi Dam. The Lower Bridge River is an adjacent system that supports spawning and rearing by many of the same fish species. Water temperatures are directly associated with incubation conditions for the deposited eggs; the warmer the temperatures (within acceptable limits), the faster the eggs develop towards hatch. Given that these 'warmer' temperatures occur during the spawning and incubation periods for the salmon species that utilize the channel, they are likely associated with accelerated incubation and earlier emergence of fry from the gravels relative to pre-regulation conditions. This hasn't yet been documented for the Lower Spawning Channel, but earlier emergence of chinook fry has been observed in the Lower Bridge River where the regulated flow release temperatures are warmer than historical temperatures by a few degrees (Sneep and Hall 2010).

Differences were noted between the two temperature monitoring stations within the spawning channel. Diel variations in temperature were more significant at the downstream end of the channel relative to the upstream end (Figure 2). In other words, channel temperatures are poorly buffered against changes in ambient temperatures within each 24-hour period. At the downstream end of the channel, temperatures were up to 3.5 degrees warmer during afternoon periods in the summer, and 0.5 to 1.0 degrees cooler at night, relative to the upstream (inlet) end. Total diel temperature change was therefore up to 4.5 degrees per day (Figure 3). These changes are within acceptable limits for fish, but indicate that water temperatures in the channel are fairly sensitive to changes in atmospheric conditions, given its length. This sensitivity is due to the relatively low flow volume, low velocities, and minimal riparian cover (particularly in the form of medium- and large-sized vegetation species) along most of the channel length. Wide temperature fluctuations can be a source of physiological stress for fish, and may contribute to early hatch or increased mortality for incubating eggs.

During the study period, air temperatures varied between -20.0 and +40.4 degrees Celsius on the coldest and warmest date, respectively.

3.2 Aquatic Invertebrates

In all, 800 invertebrates were enumerated from the six invertebrate samplers deployed in summer 2010, representing 17 different taxa (Table 1). Overall, the dominant taxon were mayflies (Order *Ephemeroptera*), and the baskets deployed in riffle habitats contributed the largest number of invertebrates.

Table 1 Number and type of invertebrates enumerated from six basket samplers deployed in the Lower Spawning Channel from 30 July to 25 August, 2010.

Taxon	Invertebrate ID	Habitat Type			Totals
		Run	Pool	Riffle	
Amphipoda	Scud	3	73		**76**
Chironomidae	Blood worm		4		**4**
Chironomidae	Midge	25	58	80	**163**
Coleoptera	Beetle		3		**3**
Crane fly	Crane fly	5			**5**
Ephemeroptera	Mayfly Type 1	41	2	119	**162**
Ephemeroptera	Mayfly Type 2		27	2	**29**
Ephemeroptera	Mayfly Type 3		2	2	**4**
Gastropoda	Snail Type 1	12	18		**30**
Gastropoda	Snail Type 2	11	13		**24**
Hirudinea	Leech	3	1		**4**
Hydracarina	Water mite		1	1	**2**
Odonata	Dragonfly	2	1		**3**
Oligochaete	Worm	43	10		**53**
Plecoptera	Stonefly	18	1	23	**42**
Simuliidae	Black fly	29		90	**119**
Trichoptera	Caddisfly	21	13	43	**77**
Totals		**213**	**227**	**360**	**800**

The abundance and taxonomic diversity data also were analyzed using a set of formulas and criteria provided in The Streamkeepers Handbook--Module 4 as a very general way of extrapolating any potential issues with water quality or habitat conditions in the channel (DFO 2000; Table 2).

Table 2 General indices which may reflect overall water quality and habitat conditions in the channel, derived from the aquatic invertebrate data.

Criterion	Habitat Type							
	Run		Pool		Riffle		All	
	Value	Rating	Value	Rating	Value	Rating	Value	Rating
# Bugs Sampled	213		227		360		800	
Dominant Taxon	Oligochaete		Amphipoda		Ephemeroptera		Ephemeroptera	
Pollution Tolerance Index	22	Acceptable	20	Acceptable	12	Marginal	26	Good
EPT Index	3-4	Marginal	5	Marginal	5-6	Acceptable	5-7	Acceptable
EPT to Total Ratio	.38	Marginal	.20	Poor	.53	Acceptable	.39	Marginal
Total # of Taxa	12		15		8		17	
Dominant Taxon Ratio	.20	Good	.32	Good	.34	Good	.24	Good
Overall Rating	**2.75/4**	Acceptable	**2.50/4**	Acceptable	**3.00/4**	Acceptable	**3.25/4**	Acceptable

Overall, the analysis of the aquatic invertebrate data does not suggest a likelihood of significant water quality issues in the channel. The overall index for pollution tolerant organisms was good, the EPT index was acceptable; the EPT to Total Ratio was marginal; the Dominant Taxon Ratio was good, for an Overall Rating of 3.25 out of 4 (or acceptable). The ratings for the individual habitat types have also been provided in the table for comparison purposes, but should not be taken as a reflection of conditions in the channel as a whole on their own.

The overview survey of the channel prior to the start of sampling revealed a skewed distribution of habitat types by area: the vast majority of the channel is comprised of shallow runs. The contribution of pool and riffle habitats is much less. The obvious reason for this is that the channel was originally designed for pink salmon spawning, so the intention was to maximize spawning platform area. However, now that the channel has been complexed and is continuously wetted for use by other species and life stages, the skewed distribution of habitat types may not provide the optimal conditions for maximizing the potential abundance and diversity of aquatic invertebrates. Riffles are typically very productive habitat areas for aquatic invertebrates. Depending on the priorities for intended use of the channel (e.g., spawning, rearing, feeding, etc.), the production of aquatic invertebrates for biodiversity and as food resources for fish could potentially be increased by adding and enlarging the riffle areas.

3.3 Periphyton Accrual

Results from the periphyton accrual sampling were documented by photographing the plates at the end of the 6-week deployment. The photos are provided in Appendix B, Photos 1 to 6 (Photos provided by Kim North). Plate 3 (in Run habitat) appeared to have the highest overall growth. Also, the plates deployed in the lower half of the channel may have had higher accrual than the plates in the upstream portion (although this was difficult to truly compare since a bear had disturbed or damaged a couple of the plates by the end of the sampling period).

The growth of algae between sampling locations is typically quite variable. The high level of variability reflects the fact that spatial and temporal patterns of periphyton growth are influenced by a complex set of microhabitat variables, which include: water chemistry parameters, ambient light intensity, depth, and flow velocity. A more quantitative sampling strategy would be required in order to determine any possible trends in the data for this parameter.

3.4 Resident and Juvenile Fish

In all, 101 fish were sampled from the Lower Spawning Channel using minnow traps (Table 3). The seven species represented in the catch included: chinook and coho salmon (*Oncorhynchus tshawytscha* and *Oncorhynchus kisutch*), rainbow trout (*Oncorhynchus mykiss*), bridgelip sucker (*Catostomus columbianus*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), and coastrange sculpin (*Cottus aleuticus*). One additional species, mountain whitefish (*Prosopium williamsoni*), was observed in the channel but not captured.

The numbers of fish captured in each habitat type is likely as much a reflection of sampling effort and the limitations of the method than actual fish distribution. More effort was applied to runs (total = 1058.6 hours) than the other types (pool = 189.8 hours; riffle = 200.1 hours) because of the predominance of run habitats in the channel. Also, the traps may not have captured or held fish as effectively in pool habitats with little to no flow (i.e., observer efficiency was much higher than capture efficiency in pool habitats).

Table 3 Summary of fish captured in the Seton River Lower Spawning Channel, 17 to 25 August 2010.

Species[a]	**Habitat Type**			
	Run	**Pool**	**Riffle**	**All**
Chinook salmon	5			**5**
Coho salmon	10		1	**11**
Rainbow trout	8		2	**10**
Bridgelip sucker	40	3	5	**48**
Longnose dace	17		1	**18**
Redside shiner	5	2	1	**8**
Coastrange sculpin		1		**1**
Total	**85**	**6**	**10**	**101**

[a] Mountain whitefish also were observed, but not captured.

Interestingly, the species assemblage reflected in the catch data includes species that are typically stream resident and species that are more typically lake resident within the Seton River watershed. Some of the species that are not typically observed in the Seton River itself, may have colonized the channel, possibly following entrainment out of Seton Lake, because it provides habitat attributes that meet their requirements. Clearly the channel includes a unique combination of habitat features that are not available in the river or its natural sidechannels. However, before any more definitive conclusions can be drawn (e.g., complete species assemblage, relative abundance, and distribution of fish in the channel), a much more rigorous sampling design would need to be implemented.

3.4 Salmon Spawners

Four species of salmon spawners were observed in the Lower Spawning Channel in 2011. Pink salmon (*Oncorhynchus gorbuscha*) were by far the most numerous, followed by sockeye salmon (*Oncorhynchus nerka*; Table 4). Chinook and coho salmon adults also were recorded, but only in very low numbers. As such, they were not included in the table below.

Adult pink salmon were first observed in the channel on 15 August; the peak count occurred on 26 September, and the last live pinks were recorded on 11 October. In addition to the live spawners, the dead carcasses were also enumerated. Based on the time lag between the abundance curves for live and dead spawners (Figure 4), the average channel residence time for the pinks was ca. 19 days, which is similar to the values reported in the literature. According to the area-under-the-curve calculation, the total escapement of pinks to the Lower Spawning Channel in 2011 was ca. 4000 fish.

Table 4 Results of salmon spawner surveys in the Lower Spawning Channel, 8 August to 14 November 2011.

Survey #	Date	Pink Salmon			Sockeye Salmon		
		Live	Dead	Total	Live	Dead	Total
1	8 Aug				77	69	146
2	15 Aug	4		4	69	66	135
3	23 Aug				1	14	15
4	6 Sep	85	5	90	2		2
5	12 Sep	189	12	201	2		2
6	19 Sep	1301	15	1316	1		1
7	26 Sep	1908	200	2108			
8	4 Oct	937	1540	2477	2		2
9	11 Oct	376	1492	1868			
10	23 Oct		924	924			
11	7 Nov						
12	14 Nov						
Escapement Estimate				**4003**			**ca. 200**

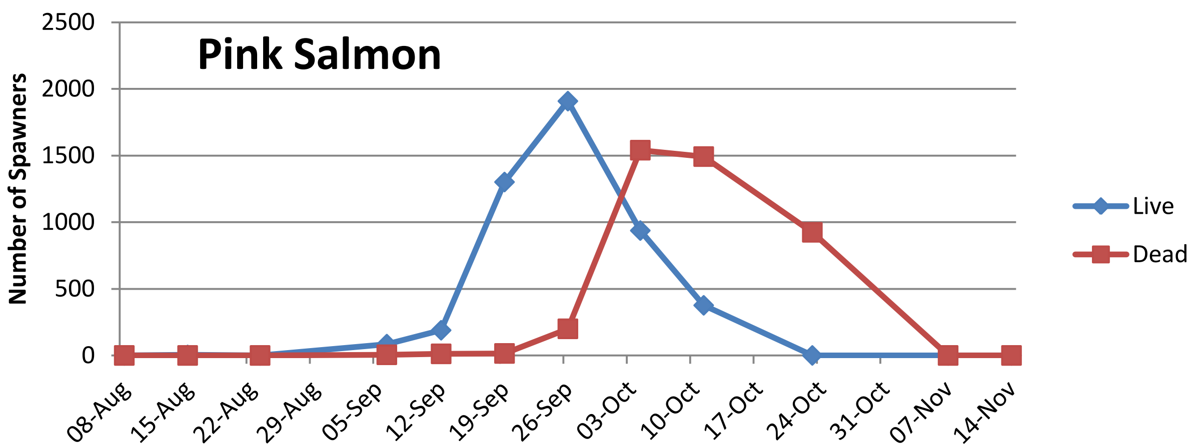

Figure 4 The number of live and dead pink salmon spawners enumerated during each survey, August to November 2011.

Based on the spawner abundance and distribution data from the surveys, it was noted by the field crews that several sections of the spawning channel seemed under-utilized by pink spawners in 2011 (Figure 5). Some sections had consistently higher numbers of spawners, and some had relatively few. It appeared in the field that the areas with higher abundance were typically associated with the sections that had been complexed and had gravel maintenance work done ca. 8 years ago (Odin Scholz, pers. comm.). To evaluate this potential correlation further, the pink spawner distribution data were summarized according to the different types of gravel treatment that were completed in 2003 (Table 5). A map showing the different habitat complexing and gravel treatments applied to the channel is provided in Figure 6.

Interestingly, based on this comparison, the highest proportions of spawners were observed in the sections where the gravels had been scarified (ca. 60%) and cleaned (ca. 25%). The lowest proportion was observed in the sections that were left undisturbed (i.e., no gravel maintenance; ca. 15%). These results do support the anecdotal reports from the field and appear to confirm that gravel maintenance plays a role in influencing use of different areas of the channel by spawners. However, the reasons why the use of sections that had gravel cleaning was so much less than the areas that had been scarified is not clear. Without knowing the difference in procedure for scarification versus cleaning of the gravels, it is not appropriate to speculate about what might be the causes of the differences in use between these two treatment types. Even though many pink salmon were enumerated this year, it is clear that if every section of the channel were able to support spawners in more equivalent density, the potential for spawning use could be much higher than what was observed in 2011. Perhaps gravel scarification or cleaning could be a means of improving the suitability of the under-utilized sections for spawning.

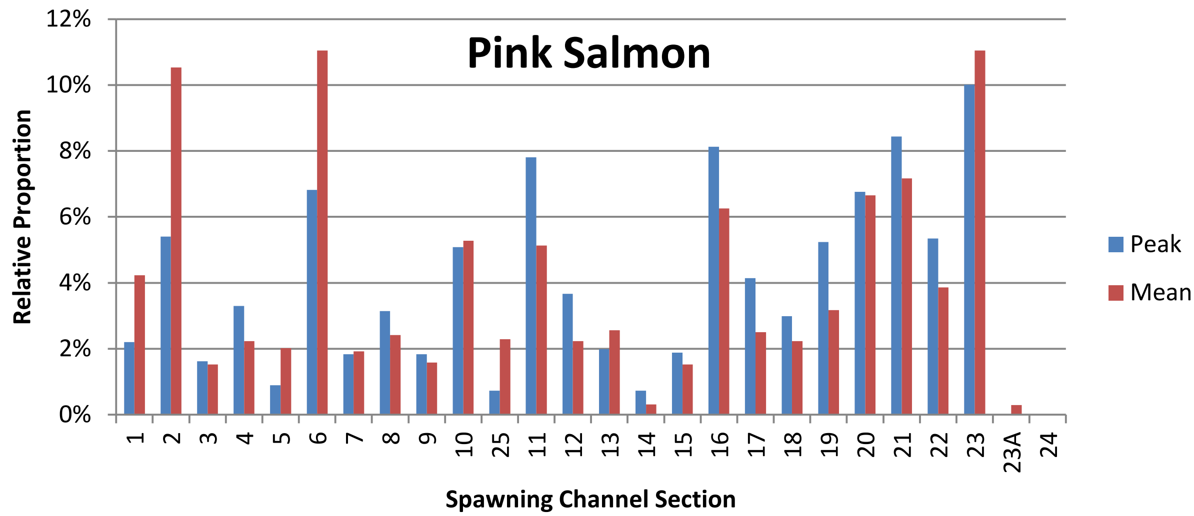

Figure 5 The relative distribution of live pink salmon spawners by section of the Lower Spawning Channel (from Figure 1). The blue bars represent the proportions during the peak count; the red bars represent the mean proportions.

Table 5 The distribution of live pink salmon spawners relative to the types of gravel maintenance treatments that were applied to the channel in 2003. The results were stratified according to the proportion of each treatment to the total channel length.

Gravel Treatment	Relative Proportions of Spawners at Peak Count	Mean Proportions of Spawners
Undisturbed (34%)[a]	14%	15%
Scarified (37%)	55%	60%
Cleaned (29%)	31%	25%

[a] Percentage of total channel length where this treatment method was applied.

Sockeye salmon were the next most abundant species of spawners observed, and were already present in the channel on the date of the first survey. Based on anecdotal reports for the period prior to the 8 August survey and the condition of the spawners and carcasses on that date, it seemed likely that the count for this survey (*n*=146) represented the peak number. The count was almost equally split between live and dead fish. Upon closer examination, it became apparent that a majority of the carcasses were unspawned females. Given the lack of obvious redd construction in the channel at this time and the early mortality, it seems likely that these fish were part of another stock that had strayed into the spawning channel because of injury or premature exhaustion and were unable to make it to their intended spawning grounds. Genetic samples were collected by DFO personnel to determine a stock identity for these fish, but those data were unavailable at the time of writing for this report. The total escapement of sockeye spawners to the Lower Spawning Channel in 2011 was estimated to be between 150 and 200 fish.

Chinook and coho salmon were observed in very low numbers in the spawning channel during 2011 (*n*=1 and 3, respectively). The single chinook spawner was observed on the 23 August survey, and the coho spawners were observed during the 7 and 14 November surveys. Given the presence of rearing juveniles for each of these species in the channel, it is possible that these fish may spawn here as well. However, given the lack of preferred spawning habitats for these species in the channel, it is also likely that they were holding in the channel before moving into the Seton River or elsewhere to spawn. Once they reach an appropriate size, the juveniles may migrate into the channel from the Seton River for rearing.

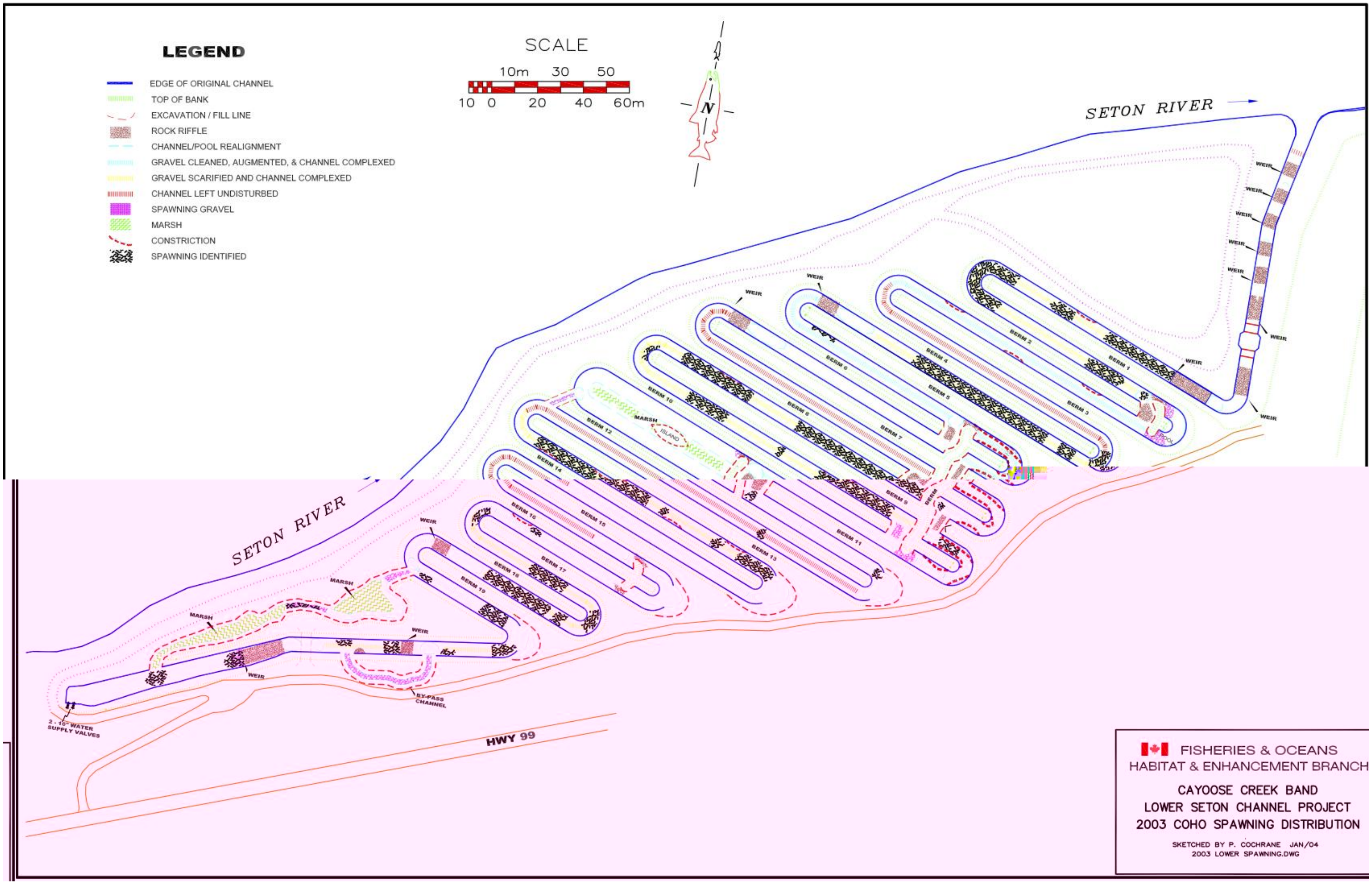

Figure 6 An overview map of the Seton River Lower Spawning Channel illustrating the various habitat complexing works completed in 2003.

4.0 Conclusions and Recommendations

The protocols for sampling in the Lower Spawning Channel during 2010 were designed as a preliminary assessment of temperature conditions, aquatic invertebrate diversity, and presence of resident and juvenile fish in summer. The work in 2011 was intended to document use of the channel by salmon spawners and collect a more comprehensive set of temperature data. The sampling in both years also provided important training opportunities for participants in the Seton River corridor restoration project, and the data were meant to inform the direction of future efforts and funding applications. As intended, the work provided those opportunities and contributed to the development of the following recommendations:

> Based on the results of the 2011 salmon spawner surveys, it appeared that the distribution of spawners varied between individual sections of the channel, and many areas of spawning habitat were minimally used by the spawners. Crews noted that the sections with higher spawner distribution were typically associated with the areas where instream works (i.e., large woody debris placement and gravel maintenance) had been completed most recently, and the data seems to support those observations. These results suggest that assessing the condition of the gravel spawning platforms (in terms of compaction, infiltration of fines and decomposing organic materials, etc.) throughout the channel length would be important for determining the potential need for gravel rehabilitation works in the form of scarification and/or cleaning.
>
> Documenting salmon spawner escapement provides important information for monitoring use of the available spawning habitats in the channel. But gaining a better understanding of the suitability of those habitats in terms of spawning success and juvenile recruitment would require some measure of hatch success or fry production. One way to address this could be to sample pink fry in the spring as they migrate out of the channel. This sampling has been done in the past and the infrastructure still exists near the downstream end of the channel. The condition of this infrastructure would need to be assessed in order to ensure that it is still in working order. The continuous water temperature data available from the loggers could be used to predict the timing of hatch and emergence in order to schedule the timing of sampling.
>
> Much of the channel has very minimal riparian cover which undoubtedly contributes to the wider diel temperature fluctuations along much of its length. Consider the potential for planting native vegetation that would provide overhead cover and shade to buffer this effect. This vegetation would also contribute to wildlife and bird habitats along the channel edges.
>
> The channel is currently dominated by shallow run-type habitats with fairly uniform gravel substrates because of its original design as a pink salmon spawning channel. Depending on the priorities for use of the channel, consideration could be given to enlarging and/or increasing the number of riffle habitats since they can be significant contributors to aquatic bug production, and are preferred habitats for certain species and lifestages of fish (e.g., mountain whitefish, rainbow trout/steelhead parr).

The sampling protocols employed for the resident and juvenile fish survey in 2010 were fairly generalized, which was appropriate for the goals and objectives of a preliminary assessment. To better address gaps in information about use of the channel by resident fish species and juvenile lifestages, consider implementing a more rigorous sampling design to document fish distribution, relative abundance, growth, and a more complete species assemblage. This recommendation could be particularly important if future restoration works are implemented in the channel, such that associated changes to fish use or aquatic bug production, etc. could be monitored.

5.0 References Cited

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English, K.K, R.C. Bocking, and J.R. Irvine. 1992. A robust procedure for estimating salmon escapement based on the area-under-the-curve method. Canadian Journal of Fisheries and Aquatic Sciences 49: 1982-1989.

Sneep, J., and S. Hall. 2010. Lower Bridge River Aquatic Monitoring: Year 2009 Data Report. Unpublished report prepared for the Deputy Comptroller of Water Rights, August 2010.

APPENDIX A
2010 WATER TEMPERATURE DATA

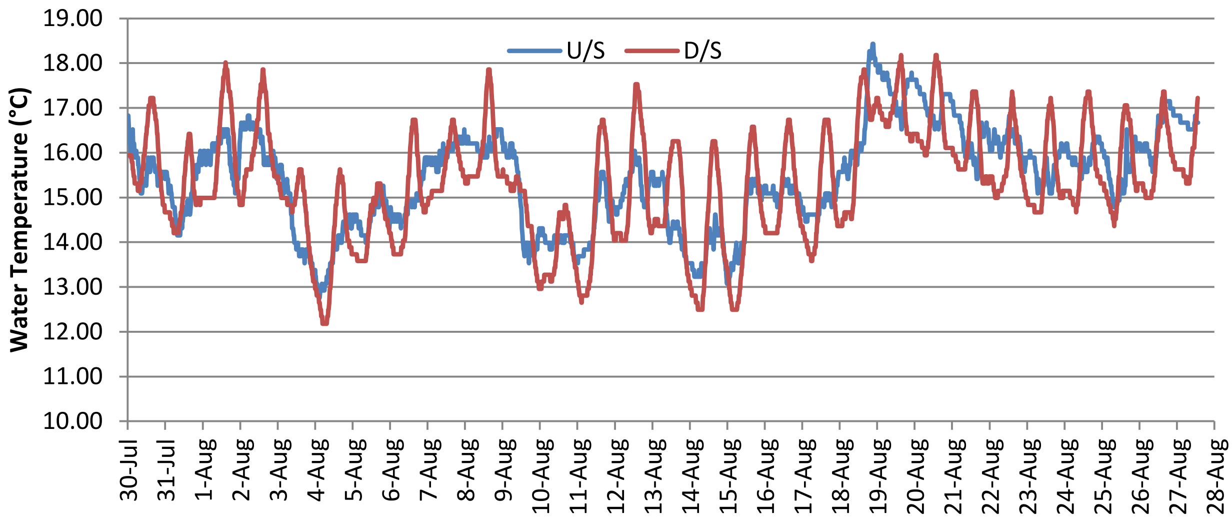

Figure A1 Water temperatures recorded at the upstream and downstream ends of the Seton River Lower Spawning Channel, 30 July to 27 August 2010.

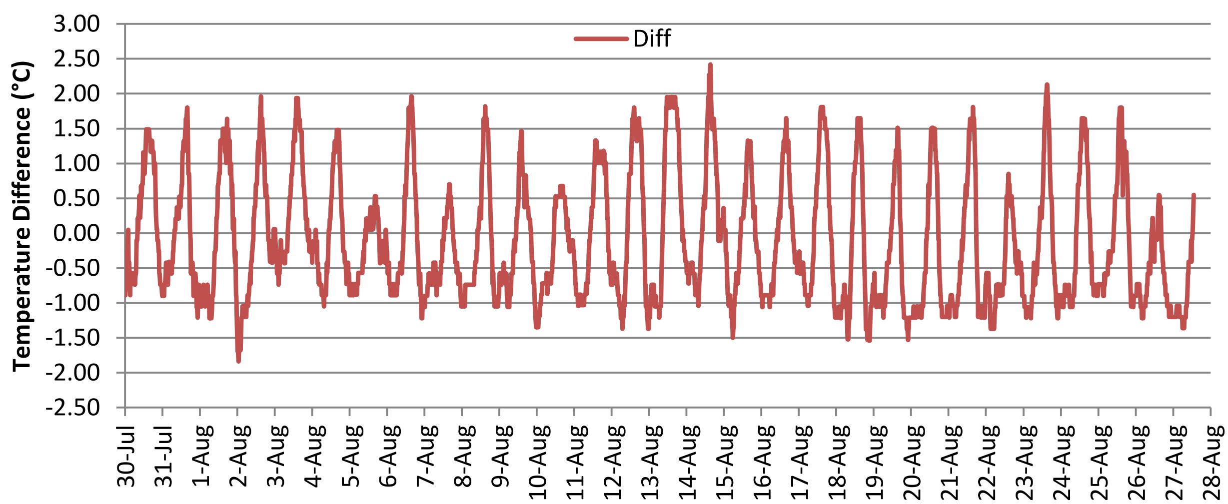

Figure A2 Differences in water temperature between the upstream and downstream ends of the Seton River Lower Spawning Channel, 30 July to 27 August 2010.

APPENDIX B
PERIPHYTON ACCRUAL PHOTOS

Photo 1: Periphyton Accrual Plate #1 -- Riffle
Lower Section

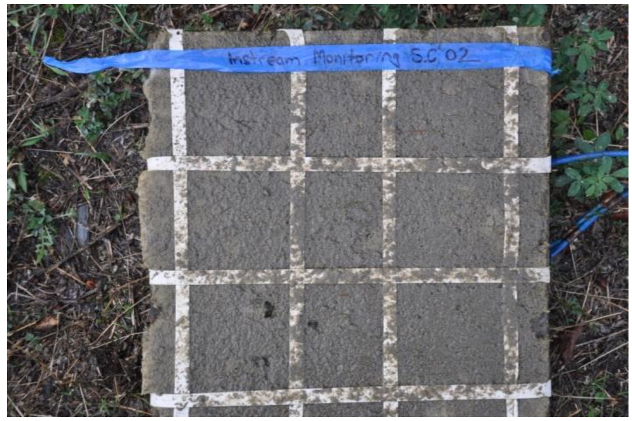

Photo 2: Periphyton Accrual Plate #2 -- Pool
Lower Section

Photo 3: Periphyton Accrual Plate #3 -- Run
Lower-Middle Section

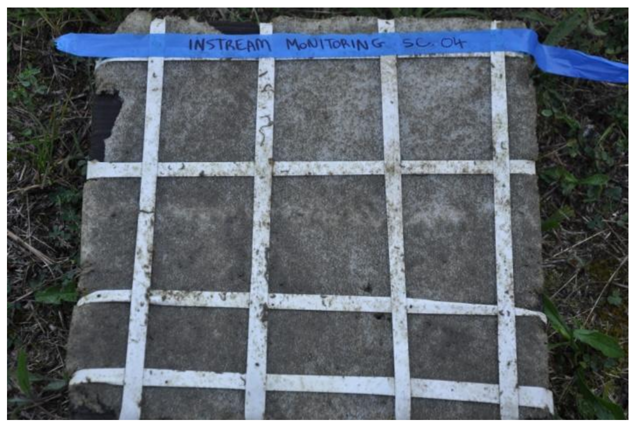

Photo 4: Periphyton Accrual Plate #4 -- Pool
Upper-Middle Section

Photo 5: Periphyton Accrual Plate #5 -- Riffle
Upper Section

Photo 6: Periphyton Accrual Plate #6 -- Run
Upper Section

Photos Courtesy of Kim North